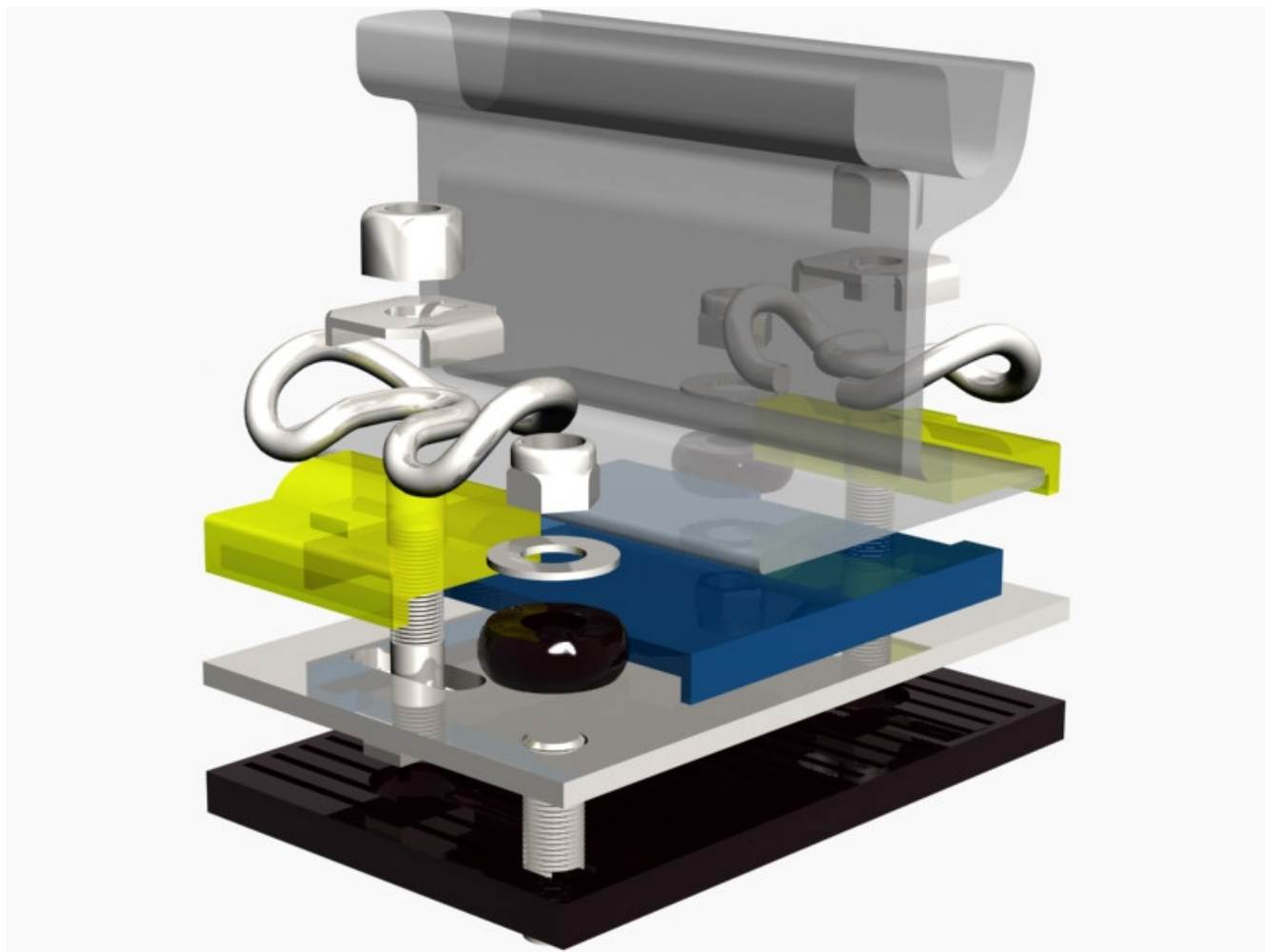


## DOUBLE ELASTIC RAIL FASTENING SYSTEM " DEPP " ®



### GENERAL

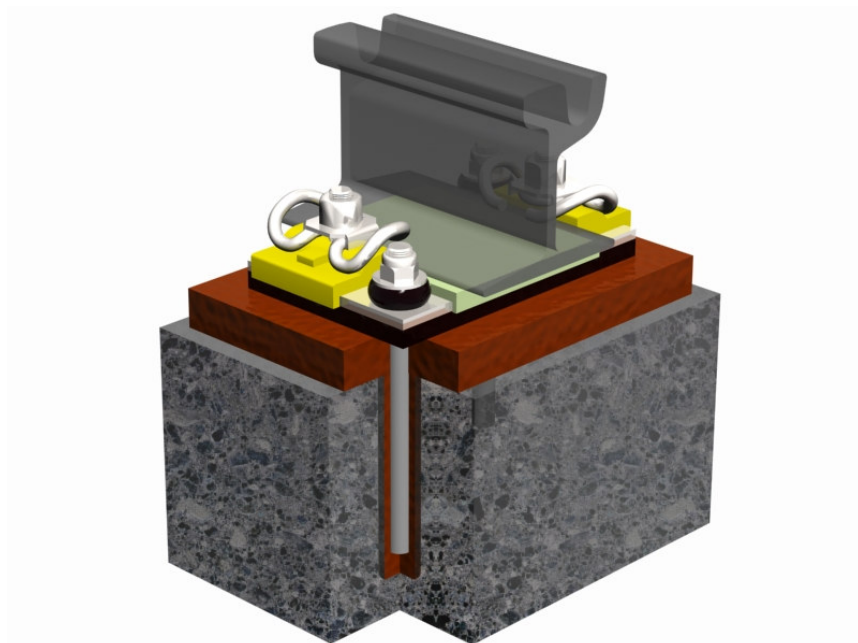
DEPP rail fastening system has been developed for the conditions of heavier static and dynamic loads on the concrete light rail and tram tracks. Owing to the placement of a steel plate between two specifically shaped elastomers, by fitting an elastomeric spring on the anchoring screw and by use of a well-proved elastic clip Skl-1, it transmits vehicle load from the rail to the concrete foundation extremely well, and with a high reduction factor. With specifically shaped elastomeric elements placed on key fastening locations it remarkably lowers vibrations transmission and reduces noise level. The fastening system is dismountable and all its elements are replaceable and recyclable, and it does not involve any maintenance for a longer period of time.

### ADVANTAGES

- It demonstrably supports loads over 10.000.000 tons/year for over 7 years without any need for maintenance.
- It reduces shock and vibration and lowers noise level for 3-5 dB as compared to other fastening systems.
- It reduces force transmission from the rail to the concrete foundation.
- Excellent positioning of the track – recurring rail replacement is possible without fastening system demolition.
- Track paving is possible with any known paving system.

## APPLICATION METHODS

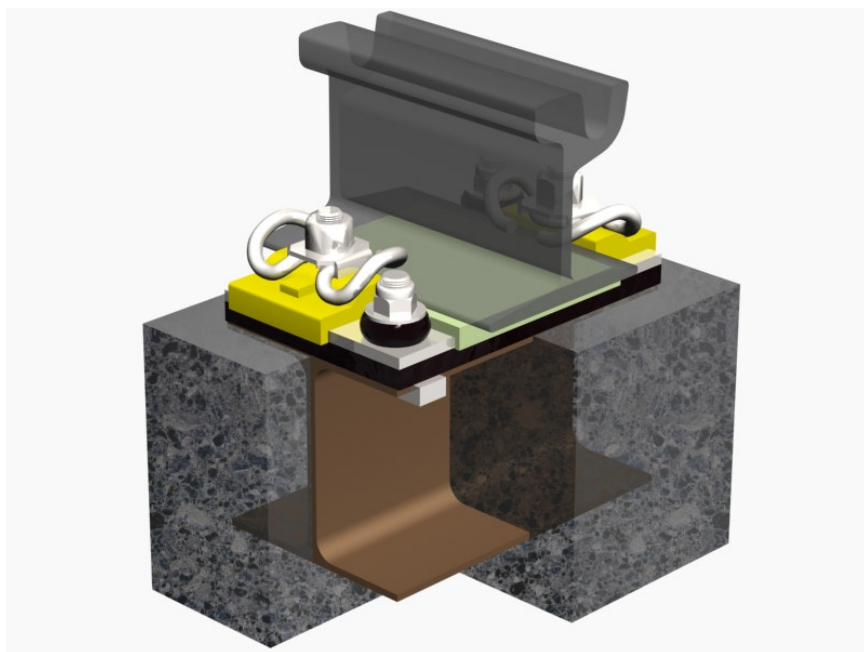
### DIRECT INSTALLATION



DEPP rail fastening system can be installed directly on the pre-constructed, 250 mm thick concrete foundation by means of anchoring screws and a levelling layer of rigid or elastic material. The foundation AB plate, ca 250 mm thick, is constructed first. After that, the fastening equipment is installed on the levelling layer of microconcrete and fixed for the concrete foundation with the anchoring screws and microconcrete.

It is applied in case of a new concrete foundation construction as well as in case of an existing concrete foundation.

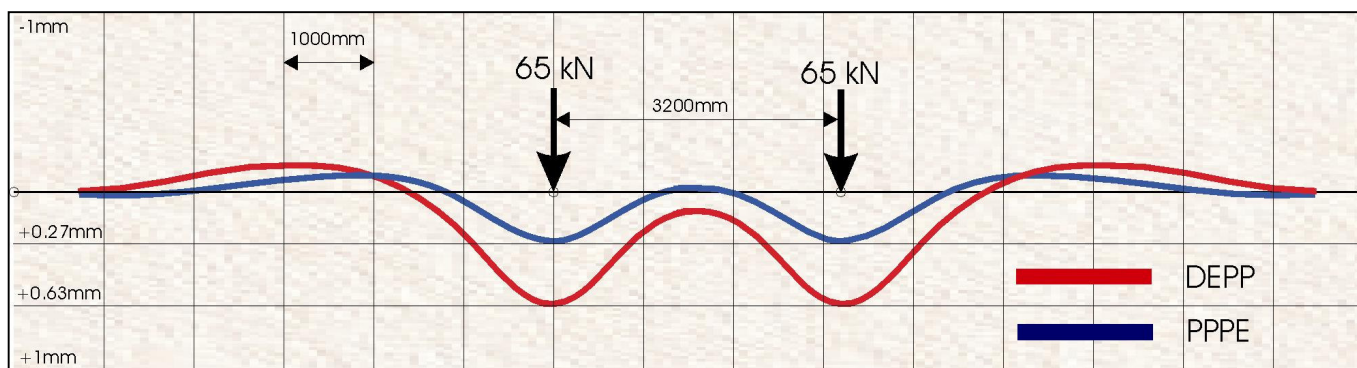
### INVERSE INSTALLATION



The track on the temporary supports is defined by height and direction. Rail fastenings are suspended on the rails with specially constructed anchorage elements and the track is coated with a 250-300 mm thick MB30 concrete.

It is applied only in case of a new concrete foundation plate construction.

## ELASTICITY



By its elasticity, DEPP is qualified as a highly elastic track fastening system which quality gives it a whole range of advantages as compared to other fastening systems used for the light rail and tram tracks. Verification of the stated claims has been done mathematically and in use on the grooved rail track of the Ri60 type. PPPE fastening system was used as a parallel. The results of the verification are shown in the above graph as well as in the tables on the right.

Bearer	One Ri60 rail
Spacing of supports	1000 mm along the rail
Load	Standard 2 x 65 kN, 3200 mm
Parallel system	PPPE type supports
Distortions at the DEPP support	0.63 mm
Maximum force at the DEPP support	37.4 kN
Distortions at the PPPE support	0.27 mm
Maximum force at the PPPE support	48.3 kN

## VERIFICATION AND TESTING

Durability and applicability verification was done at the University of Zagreb – Faculty of Civil Engineering and Faculty of Mechanical Engineering, in 1997. Fastening point was submitted to the load on a dynamic pulsator in a continuity of 4.236.400 cycles at 8,5 Hz, with the maximum force of 65 kN. Fastening point withstood testing without any problems, and the following results were obtained :

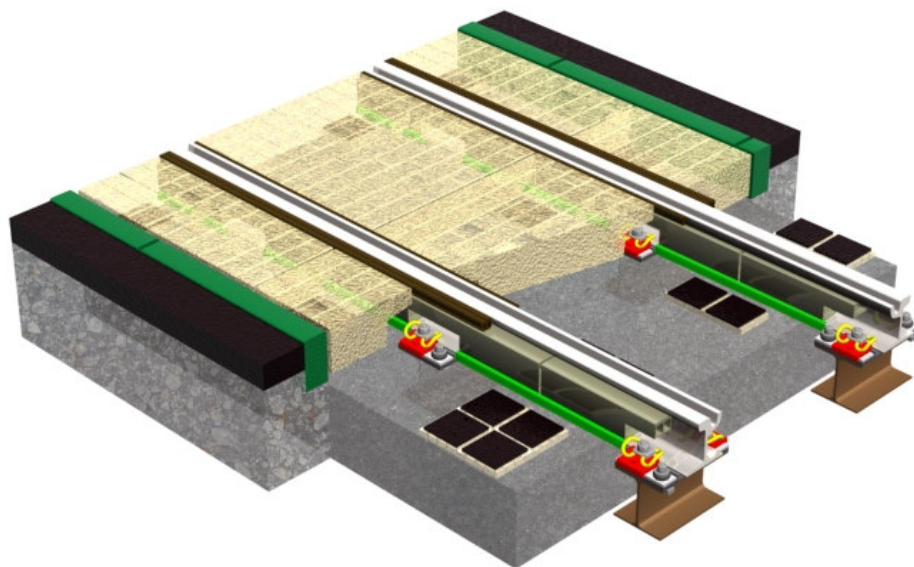
1. Elasticity feature  $C = 57.143 \cdot 10^6 \text{ N/m}$
2. There were no permanent distortions.

3. Registered extensive rise in the sample temperature during testing, which indicates high vibration transmission dumping and prevention capability.

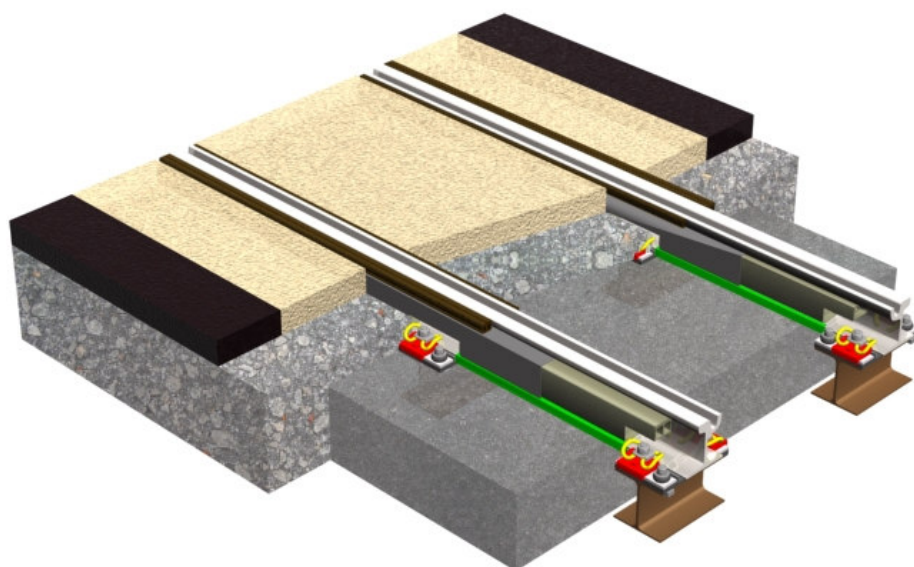
In 1998 a trial track with the DEPP fastening system was tested for noise propagation by the University of Zagreb – Faculty of Civil Engineering. It was established that such a track has 3 - 5 dB lower noise level and shorter noise duration as compared to tracks with other fastening systems.

## DEPP AND THE POSSIBILITIES OF TRACK PAVING

The track made with the DEPP fastening system can be paved with any known paving system. Two most frequently used systems, presented in the following pictures, can be highlighted as especially suitable :



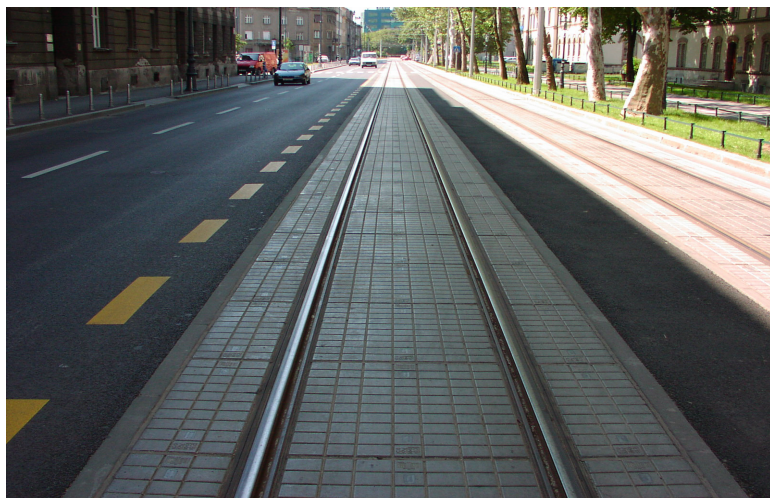
Track paved with the prefabricated AB slabs



Track paved with the asphalt



## REFERENCES



DEPP track fastening system has been in use since 1997 as a standard solution for the light rail and tram tracks in Croatia. Until today there have been installed over 80.000 DEPP type fastening points on tram tracks in Zagreb and Osijek, without any problems or objections.

## TRACK BUILDING COSTS

Track building costs in case of the DEPP fastening system application are presented in the following tables. There have been taken into consideration costs of all works and materials necessary for building of one linear meter of a completely functional track in a straight line but without track pavement. The presented costs are for two standard application methods; inverse installation and direct installation.

ITEM	INVERSE (€/m')	DIRECT (€/m')
CONCRETE BASE CONSTRUCTION	113	113
RAILS AND WELDING	213	213
DEPP FASTENINGS ACQUISITION	194	132
TRACK ASSEMBLY	41	214
OTHER WORKS	15	15
<b>TOTAL (€/m')</b>	<b>575</b>	<b>686</b>

To get an overall picture of the costs, the prices of one linear meter of track pavement for the three most frequently used methods have been illustrated in the table below. Certain differences in pavement prices are due to the differences in the local construction conditions.

TRACK PAVING METHODS	PRICE (€/m')
PAVING WITH CRUSHED STONE	15
PAVING WITH ASPHALT	270 - 345
PAVING WITH PREFABRICATED AB SLABS	905 - 1100